Title: Measure for Measure

Brief Overview

This unit will combine statistics and measurement using the graphing calculator. The students will find height and other measurements and use the graphing calculator and statistical concepts to organize and analyze data using box plots.

Links to NCTM 2000 Standards:

- **Mathematics as Problem Solving, Reasoning and Proof, Communication, Connections, and Representation**
  These five process standards are threads that integrate throughout the unit, although they may not be specifically addressed in the unit. They emphasize the need to help students develop the processes that are the major means for doing mathematics, thinking about mathematics, understanding mathematics, and communicating mathematics.

  Students will build new knowledge using statistics and data analysis to solve problems. They will use mathematical ideas to communicate the results of their investigations and analyses of data. Students also will use measurement and statistics to make connections among mathematical ideas, and as a tool to study nonmathematical ideas.

- **Measurement**
  Students will understand units and systems of measurement and will apply techniques and tools to determine measurements.

- **Data Analysis and Statistics**
  Students will collect, organize, and represent data. They will analyze and interpret data to develop and evaluate inferences and predictions.

Links to Maryland High School Mathematics Core Learning Units:

Functions and Algebra

- **1.1.1**
  Students will recognize and describe patterns that are expressed numerically.

- **1.1.2**
  Students will represent patterns in a table and graph.

Data Analysis and Probability

- **3.1.1**
  Students will conduct an investigation that uses statistical methods to analyze data and communicate results.

- **3.2.1**
  Students will make informed decisions and predictions based upon the results of data from research.

Grade/Level:

9 - 12

Duration/Length:

Three to four forty-five minute class periods.

Prerequisite Knowledge:

Students should have a working knowledge of the following skills:

- The five number summary of minimum, maximum, median, first and fourth quartiles
- Use of a graphing calculator to input lists, and find mean, median, and mode

Student Outcomes:

Students will:

- be able to establish the five number summary and components for a set of data.
- take a survey.
- construct and interpret box-and-whisker plot (ALSO REFERRED TO AS BOX PLOTS).
- use a graphing calculator to input lists and make a box plot.

Materials/Resources/Printed Materials:

- Pencils
- Graphing calculator
- Worksheets
- Measuring tape with centimeters

Development/Procedures:

This activity will use the TI-83 graphing calculator to create a box-plot and five number summary.

Day One: Use Teacher Instruction Sheet.
Day Two: Use Teacher Instruction Sheet.
Day Three: Assessment

Assessment:

Daily assessment will consist of the following. The teacher will establish the first data collection using the worksheet and overlays. Once established, the teacher will circulate among the groups to ensure that they are on task. A group evaluation will be based on performance, time on task, quality of discussion, and completion of activities.

Extension/Follow Up:

- Students can develop other sets of data and make similar analyses, e.g., grades, household size, etc. Students also can be alerted to other data sets that can be subjected to the same type of descriptions and analysis.
- Get a scale and find all the students' weights. Find the 5-number summary and make box plots. You also may be able to compare or contrast between classes.
- SAT/PSAT/ACT scores are usually compared using box plots. Also, when a student completes a career-portfolio, box plots are sometimes used to compare against other's answers.
- Have a class take a quiz. Give half the class a calculator and do not let the other half use them. You can grade and compare or contrast information among these quizzes.
- You can use box plots to compare or contrast attendance (per school in a county, per class in a school, per grade level) for a certain length of time (a week, a month, a marking period, etc.)

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DAY ONE **TEACHER INSTRUCTION SHEET**

1. Warm Up Activity: This activity is intended to review the concepts of the five number summary given a set of data. It will use the TI-83 calculator.

2. ACTIVITY ONE: Pass out Day One Activity One worksheet. Also, use the overlays for recording the results onto the overhead. Using the overlays and worksheet, use the following steps to complete.
    A. Pick 12 females.
    B. Order the students from shortest through tallest.
    C. Determine each height (in cm.).
    D. Break them into 5-number summary (Discuss percentiles, lower quartiles, where the students are within the range of the heights, how many students are in each quartile).
    E. Repeat the above steps A through D with 12 males.

** Due to the fact that the data sets will always vary, there is not an answer key available.

3. ACTIVITY TWO: The students may complete this activity for homework.

** Due to the fact that the data sets will always vary, there is not an answer key available.

** The teacher may want to collect both Activity One and Activity Four at the same time. This will help in determining accuracy and completeness.

** The teacher may want to collect both Activity Two and Activity Five at the same time. This will help in determining accuracy and completeness.

DAY ONE **WARM – UP ACTIVITY**

This activity is to review the concepts of the five-number summary and uses of the TI-83 calculator.

Using the following set of data that was collected, answer the questions:

12 15 6 12 9 2 21 17 18 17 9 10

QUESTIONS:

1. Write the collected data in ascending order.

2. Find the five-number summary for the above data.

   Minimum = _____
   Lower Quartile = _____
   Median = _____
   Upper Quartile = _____
   Maximum = _____

3. What is the highest value that a data point can be in order to be in the 25^{th} percentile?
   _____

4. What is the value of the range? _____

5. What is the value of the interquartile range? _____
   What percent of the data is in the interquartile range? _____
   How many data points are in the interquartile range? _____

6. What percent of the data is below 17? _____
   How many data points are below 17? _____

DAY ONE **WARM – UP ACTIVITY KEY**

This activity is to review the concepts of the five-number summary and uses of the TI-83 calculator.

Using the following set of data that was collected, answer the questions:

12 15 6 12 9 2 21 17 18 17 9 10

QUESTIONS:

1. Write the collected data in ascending order.

2 6 9 9 10 12 12 15 17 18 21

2. Find the five-number summary for the above data.

Minimum	= ***2***
Lower Quartile	= ***9***
Median	= ***12***
Upper Quartile	= ***17***
Maximum	= ***21***

3. What is the highest value that a data point can be in order to be in the 25^{th} percentile?
9

4. What is the value of the range? ***19***

5. What is the value of the interquartile range? ***8***
What percent of the data is in the interquartile range? ***50%***
How many data points are in the interquartile range? ***6***

6. What percent of the data is below 17? ***75%***
How many data points are below 17? ***9***

HEIGHTS

FEMALES--IN ORDER FROM SHORT TO TALL

NAME	HEIGHT
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

5-NUMBER SUMMARY

min =_____

Q1 =_____

median=_____

Q2 =_____

max =_____

HEIGHTS

MALES--IN ORDER FROM SHORT TO TALL

NAME	HEIGHT
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

5-NUMBER SUMMARY

min =_____

Q1 =_____

median=_____

Q2 =_____

max =_____

DAY ONE **NAME _____**
ACTIVITY ONE **DATE _____PERIOD____**

1) Order the 12 data from shortest to tallest
2) Fill in chart with names of the students from shortest to tallest.
3) Measure each student and match their height with their name in the chart.
4) Find the five-number summary.

HEIGHTS -- Females

NAME	HEIGHT
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

5-NUMBER SUMMARY

min =_____

Q1 =_____

median =_____

Q2 =_____

max =_____

1) How many females are in the lower quartile? Who are they?
_____

2) What percent are in the interquartile range? How many females are in the interquartile range? Who are they and how tall are they? _____
_____

3) Who is the tallest female and how tall is she? _____

HEIGHTS -- Males

NAME	HEIGHT
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

5-NUMBER SUMMARY

min =_____

Q1 =_____

median =_____

Q2 =_____

max =_____

1) How many males are in the lower quartile? Who are they?
_____

2) What percent are in the interquartile range? How many males are in the interquartile range? Who are they and how tall are they? _____
_____

3) Who is the tallest male and how tall is he? _____

DAY ONE **NAME _____**
ACTIVITY TWO **DATE _____ PERIOD ____**

DIRECTIONS:

Survey forty (40) people. There must be twenty males and twenty females. The survey is to figure out what number they would pick between the numbers 1 and 20. Fill in the chart that follows and answer the questions pertaining to the data collected.

SUVERY -- PICK A NUMBER

DATA (ANSWERS)

MALES		**FEMALES**	

1) Find the five number summary for the above collected data:
Minimum = _____
Lower Quartile = _____
Median = _____
Upper Quartile = _____
Maximum = _____

2) What is the range? _____

3) What is the interquartile range? _____

4) What number is the 25^{th} percentile? _____

5) What number is the 75^{th} percentile? _____

DAY TWO TEACHER INSTRUCTION SHEET

1. WARM-UP ACTIVITY: This is intended to review the concepts of the five-number summary and percentiles using the data collected in Day One Activity One. Use the data collection overlays and their worksheets to find the answer to the questions. The answers will vary.

2. ACTIVITY THREE: This activity is to establish the concepts of the box-plot. This activity will give instruction to use the TI-83 to create the box-plots. There are two examples (on overlays) to do as a class. Distribute handout with instructions. There is space available for the students to write the answers to the examples. Answers are on the overlays/worksheets.

3. ACTIVITY FOUR: This activity will review the concept of the box-plots and comparing using the data collected from DAY ONE. Answers will vary.

4. ACTIVITY FIVE: This activity will review creating, reading and will compare box-plots. This activity uses the information from Activity Two. This can be done for a homework assignment. Answers will vary.

** The teacher may want to collect both Activity One and Activity Four at the same time. This will help in determining accuracy and completeness.

** The teacher may want to collect both Activity Two and Activity Five at the same time. This will help in determining accuracy and completeness.

DAY TWO **WARM – UP ACTIVITY**

This activity is intended to review the concepts of the five-number summary and its components by using the data collected in DAY ONE ACTIVITY ONE by using the graphing calculator.

Write the five number summary for the data retrieved in ACTIVITY ONE.

FEMALES		MALES	
MINIMUM	= _____	MINIMUM	= _____
LOWER QUARTILE	= _____	LOWER QUARTILE	= _____
MEDIAN	= _____	MEDIAN	= _____
UPPER QUARTILE	= _____	UPPER QUARTILE	= _____
MAXIMUM	= _____	MAXIMUM	= _____

Using the above information, answer the following questions:

1) Find the ranges for both the male's and female's heights:
   MALES _____ FEMALES _____

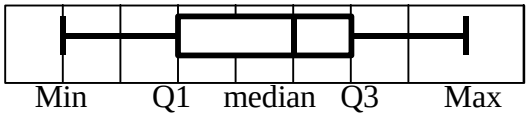
2) Find the Interquartile Range for both male's and female's:
   MALES _____ FEMALES _____

3) How many females are in the Interquartile Range? _____

4) What is the maximum height for the males? _____

DAY TWO **NAME _____**
ACTIVITY THREE **DATE _____ PERIOD ___**

BOX – PLOTS (ALSO KNOWN AS THE BOX-AND-WHISKER PLOT) are
GRAPHICAL REPRESENTATIONS of the **FIVE-NUMBER SUMMARY**



PROCEDURE FOR DISPLAYING A BOX-PLOT ON THE TI-83:

1. Clear Calculator
2. Enter data: Press **STAT**. Press **1 (EDIT)**.
   a. Place data into L1.
   b. Press **2nd** . Press **Y= (STAT PLOT)**

   c. Turn on a Plot (Plots 1 through 4) press corresponding number (**1, 2, 3, or 4**)
   d. Turn ON (press **ENTER**)
   e. Arrow down once. Arrow to the right four times. Press **ENTER.**

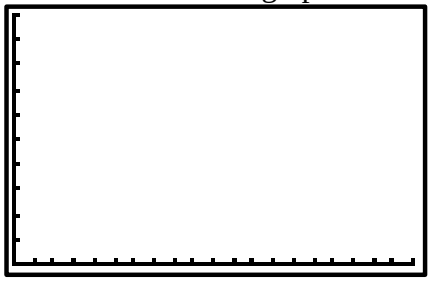
   f. Arrow down once. Make Sure XLIST is the same as the list the data is entered in. (Press **2nd**, then **1, 2, 3, 4, 5, or 6**)
   g. Press **ZOOM 9** (**Zoom Stat**)

TO DETERMINE THE FIVE-NUMBER SUMMARY USING THE BOX-PLOT

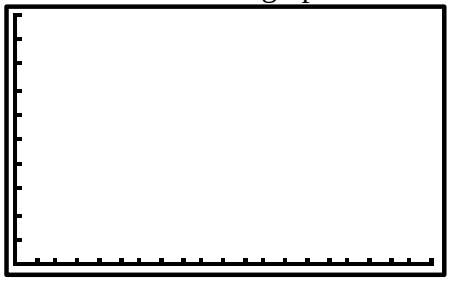
   a. Press **TRACE**
   b. Use the left or right arrow key
   c. The bottom left hand corner display the actual numbers

EXAMPLES:

Place Example 1 information in List 1
Display box-plot in Plot 1
Sketch and label the graph



Place Example 2 data in List 2
Display box–plot in Plot 1
Sketch and label the graph

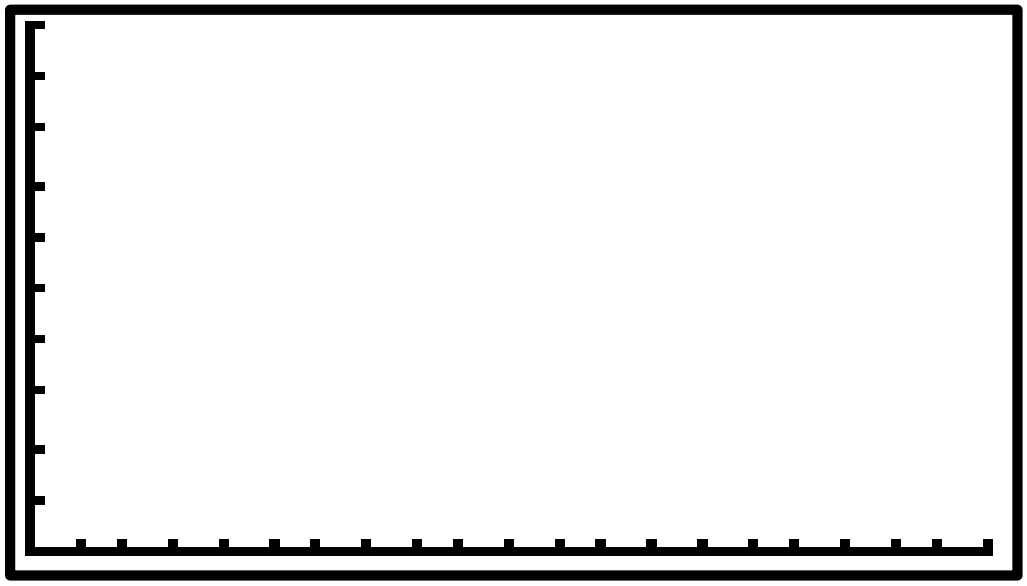


Example 1:

Using the following data points, make a box-plot:

1) Put the data into List1.
2) Create the box-plot in Plot1.

9	15	21	18	16	6	8	17
14	12	9	6	2	12	15	10



Example 2:

Use the following data points to make a box-plot:

0 -1.5 1.5 4 8 6 -4.5 -2.1

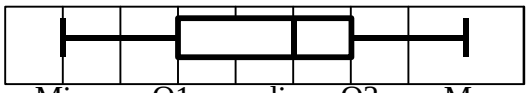
1) Enter the data into List2.
2) Display the box-plot in Plot1.

DAY TWO **NAME _____**

ACTIVITY THREE **DATE _____ PERIOD ___**

KEY

BOX – PLOTS (ALSO KNOWN AS THE BOX-AND-WHISKER PLOT) are **GRAPHICAL REPRESENTATIONS** of the **FIVE-NUMBER SUMMARY**



PROCEDURE FOR DISPLAYING A BOX-PLOT ON THE TI-83:

1. Clear Calculator
2. Enter data: Press **STAT**. Press **1 (EDIT)**.
   a. Place data into L1.
   b. Press **2nd** . Press **Y= (STAT PLOT)**

   c. Turn on a Plot (Plots 1 through 4) press corresponding number (**1, 2, 3, or 4**)
   d. Turn ON (press **ENTER**)
   e. Arrow down once. Arrow to the right four times. Press **ENTER.**

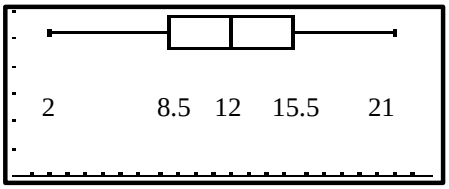
   f. Arrow down once. Make Sure XLIST is the same as the list the data is entered in. (Press **2nd**, then **1, 2, 3, 4, 5, or 6**)
   g. Press **ZOOM 9** (**Zoom Stat**)

TO DETERMINE THE FIVE-NUMBER SUMMARY USING THE BOX-PLOT

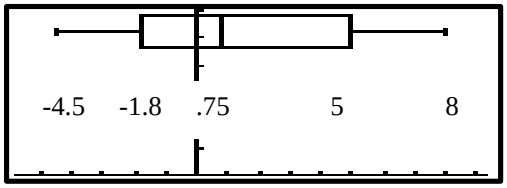
a. Press **TRACE**
b. Use the left or right arrow key
c. The bottom left hand corner display the actual numbers

EXAMPLES:

Place Example 1 information in List 1
Display box-plot in Plot 1
Sketch and label the graph



Place Example 2 data in List 2
Display box–plot in Plot 1
Sketch and label the graph

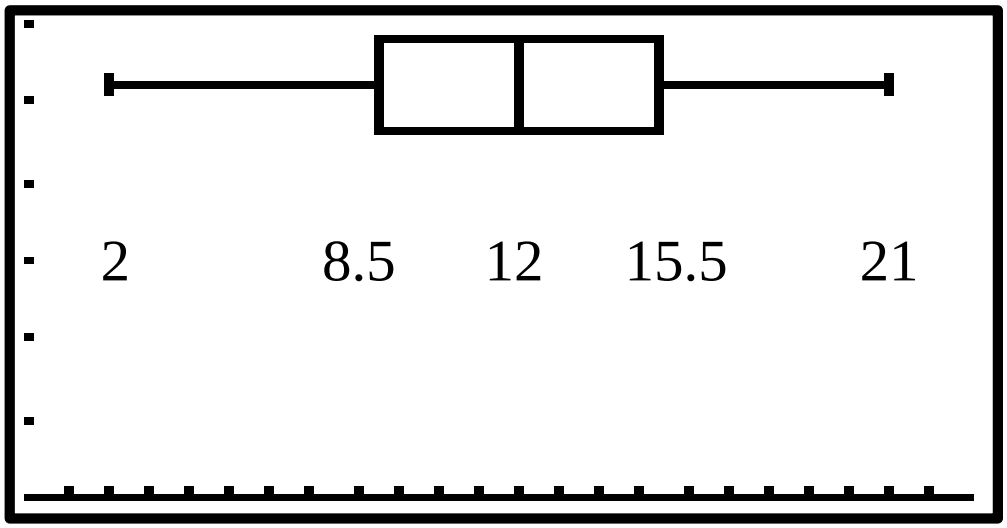


Example 1: ***KEY***

Using the following data points, make a box-plot:

1) Put the data into List1.
2) Create the box-plot in Plot1.

9	15	21	18	16	6	8	17
14	12	9	6	2	12	15	10

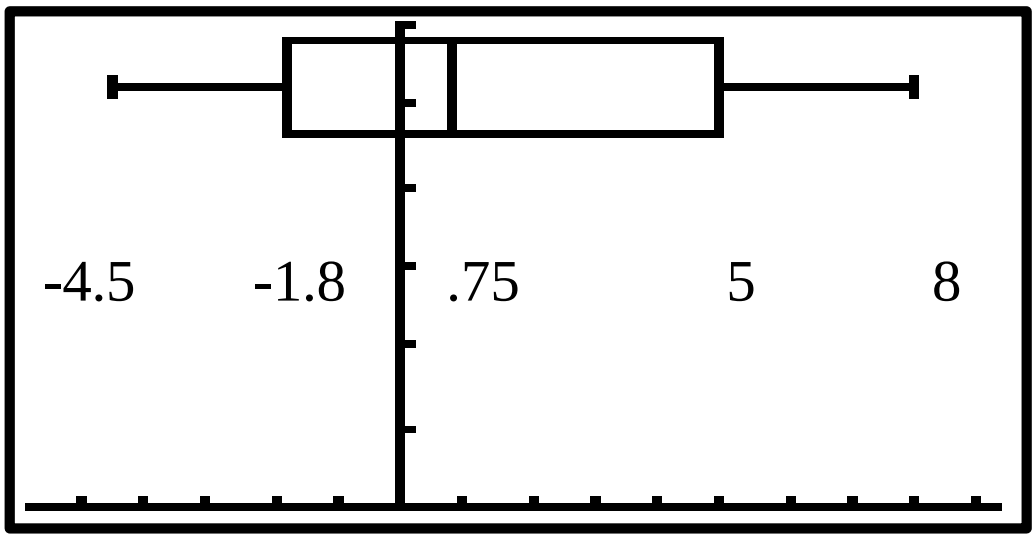


Example 2: ***KEY***

Use the following data points to make a box-plot:

1) Enter the data into List2.
2) Display the box-plot in Plot1.

0 -1.5 1.5 4 8 6 -4.5 -2.1



DAY TWO **NAME _____**
ACTIVITY FOUR **DATE _____ PERIOD _____**

Using the data collected from DAY ONE, ACTIVITY ONE, use the heights to answer the following questions:

1) FEMALES:

Write the order of the heights from least to greatest

___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

Write the five-number summary

Min = _____ Q1 = _____ Median = _____ Q3 = _____ Max = _____

2) MALES

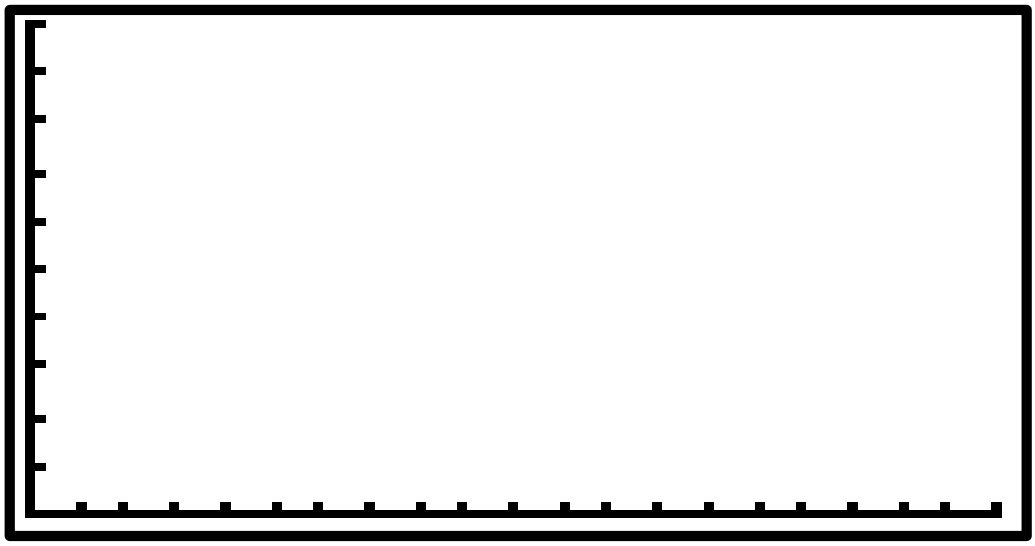
Write the order of the heights from least to greatest

___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

Write the five-number summary

Min = _____ Q1 = _____ Median = _____ Q3 = _____ Max = _____

3) Place the data for the females in List 1 and place the data for the males in List 2.
Make the box-plot for the females in Plot1 and the box-plot for the males in Plot2.
Turn both box-plots on the screen at once.
Sketch the displays on the same graph and label all parts.



4) Looking at the above box-plots, answer the following questions:

a) What percent of the males are above the upper quartile? _____

b) What percent of the females are below the lower quartile? _____

c) What height are 50% of the males below? _____

d) How many males are in the interquartile range? _____

e) What heights are the females in between for the middle 50%? _____

f) What is the shortest height of the tallest 25% of the females? _____

5) Using complete sentences, compare the following items regarding the student's heights and the box-plots. Justify the answers.

a) MINIMUM HEIGHTS:

b) LOWER QUARTILES:

c) MEDIANS:

d) UPPER QUARTILES:

e) MAXIMUM HEIGHTS:

f) INTERQUARTILE RANGES:

g) RANGE:

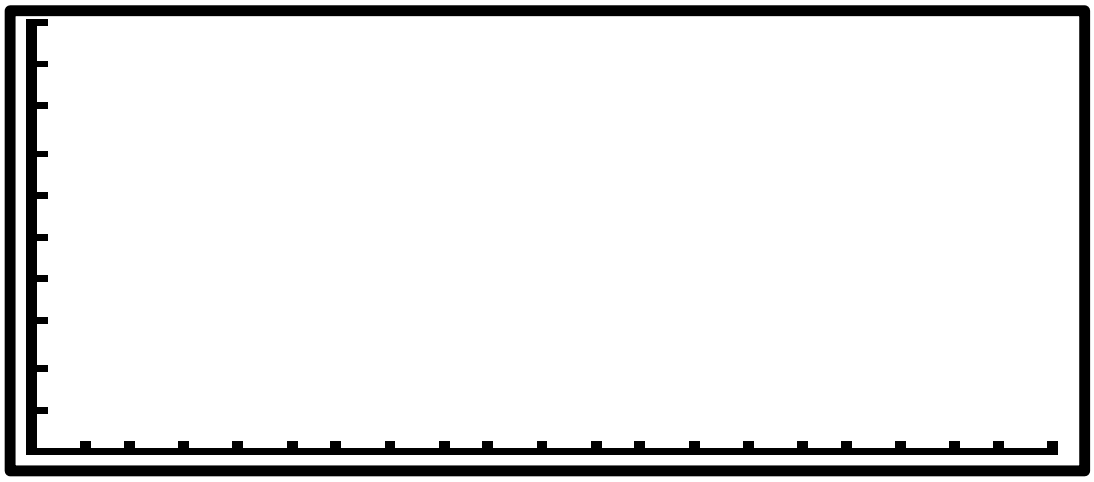
DAY TWO **NAME _____**
ACTIVITY FIVE **DATE _____ PERIOD ___**

Use the data collected from the survey in Activity Two, to complete the following:

1) Separate the data into two groups (MALES and FEMALES)

MALES		**FEMALES**	

2) Make a box-plot for the males and females. Display both of them on one screen. Sketch the graph below. **LABEL ALL PARTS**



3) In complete sentence, use the above box-plots, write at least five (5) comparisons regarding the numbers picked by females and the numbers picked by males. Justify your answers. (HINT: Use ACTIVITY FOUR)

Assessment

Teacher's Guide

Introduction

The purpose of the assessment activity is to provide teacher feedback about students' learning of box plots.

Objectives Covered

- Students will be able to establish a 5 number summary for a set of data.
- Students will determine the interquartile range of a set of data.
- Students will construct and interpret box-plots.
- Students will use a graphing calculator to input lists and make a box-plot.

Tools/Materials Needed for Assessment

- Pencil
- Calculator

Administering the Assessment

Students should complete the assessment individually. They may write directly on the assessment sheet. Students should be able to complete this assessment in approximately 30 minutes.

Assessment Scoring Guide

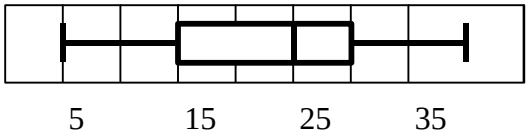
25 points total
1 point each for numbers 1 – 4
1 point for parts a to d in question 5
3 points for question 5 part e
    1 point for complete sentences
    2 points for correct explanation
14 points for question 6
    2 points for each correct display
    10 points part b (2 points for each correct sentence)

Mathematics Assessment - Measure to Measure
Student Response Sheet

Name_____ **Date** _____

For questions 1 - 4 circle the correct answer.

The number of touchdowns scored by each of 24 High Schools last year is represented by the following box-plot.



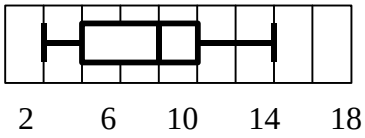
1. How many schools scored between 15 and 30 touchdowns last year?

a. 6 b. 10 c. 12 d. 15

2. What percentile of a set of data is the same as its lower quartile?

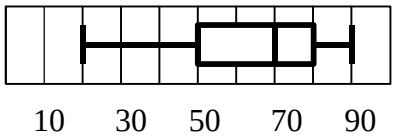
a. 25 b. 50 c. 75 d. 100

3. Given the following box-plot for a collection of 32 numbers what is the interquartile range?



a. 4 b. 6 c. 8 d. 10

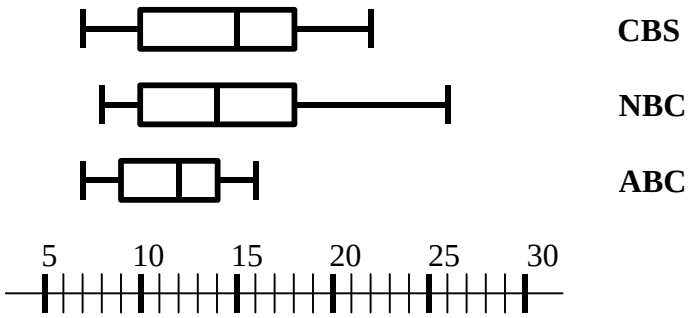
4. Given the following box-plot for a class of 28 test scores. Compare the number of students with scores in the 1st quartile to the number of students scores in the 4 th quartile.



a. $Q^1 < Q^4$ b. $Q^1 = Q^4$ c. $Q^1 > Q^4$ d. Can not determine

5. The box-plot below shows the television ratings for the three major networks.

Television Ratings



Source: A.C. Nielson Company

a. Which network has the largest interquartile range? _____

b. Which network has the highest rating based on their median score ? _____

c. Which network has the highest rating based on the highest rated show? _____

d. Which network has the highest rating based on the largest upper quartile? _____

e. When comparing the relative positions of the networks why are box-plots better than stem-and-leaf plots ?

_____

_____

_____

_____

_____

_____

Show all work in the space provided on your answer sheet.
Your work and answer will be scored.

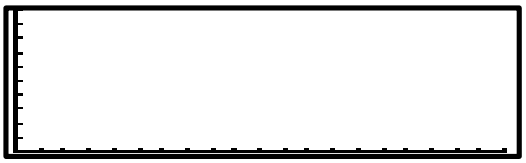
6. The National Insurance Agency rated 40 models of cars based on the number of insurance claims filed for personal injury coverage. 100 represents the average for all cars. Lower numbers mean a better safety record. A rating of 115, for example, means 15% worse than average.

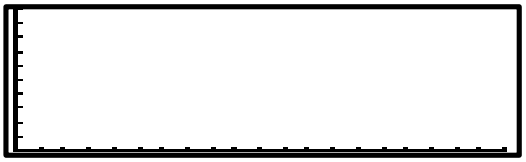
Safety Rating

Small Cars		**Large Cars**	
Mercury Lynx	83	Buick Electra	59
Toyota Tercel	91	Dodge Caravan	63
Ford Escort	95	Ford Crown Victoria	70
Subaru DL/GL98	98	Mercedes 300SD	60
Nissan Sentra	108	Jaguar X 16	63
Mercedes 380SL	57	Cadillac Eldorado	71
Chevrolet Corvette	71	Lincoln Town Car	72
Nissan 300ZX	100	Cadillac Seville	76
VW Rabbit	102	Mercury Grand Marquis	65
Mazda RX-7	104	Buick Electra	66
Pontiac Fiero	119	Chrys. 5th Ave.	69
Honda Accord	102	Ford Crown Victoria	65
Nissan Stanza	105	Buick LeSabre	70
Honda Prelude	114	Oldsmobile Delta	70
Toyota Celica	120	Mercury Grand Marquis	76
Dodge Daytona	122	Buick Electra	81
Ford Escort	130	Cadillac De Ville	81
Dodge Charger	132	Dodge Diplomat	72
Mazda GLC	130	Chevrolet Impala	79
Dodge Colt	144	Plymouth Grand Fury	101

Source: Highway Loss Data Institute

A. In order to compare the safety rating of the small cars to the safety rating of the large cars, draw a box-plot of each.





B. Using complete sentences, write 5 separate comparisons between the safety rating of small cars and large cars.

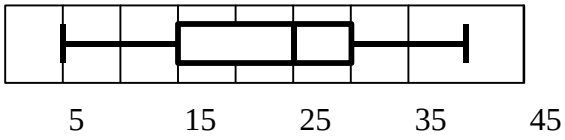
Assessment Scoring Guide

Mathematics Assessment - Measure to Measure
Student Response Sheet

Name_____ **Date** _____

For questions 1 - 4 circle the correct answer.

The number of touchdowns scored by each of 24 High Schools last year is represented by the following box-plot.



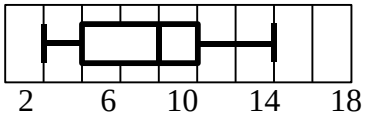
1. How many schools scored between 15 and 30 touchdowns last year?

   a. 6 b. 10 **c. 12** d. 15

2. What percentile of a set of data is the same as its lower quartile?

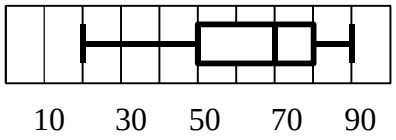
   a. 25 b. 50 c. 75 d. 100

3. Given the following box-plot for a collection of 32 numbers what is the interquartile range?



   a. 4 **b. 6** c. 8 d. 10

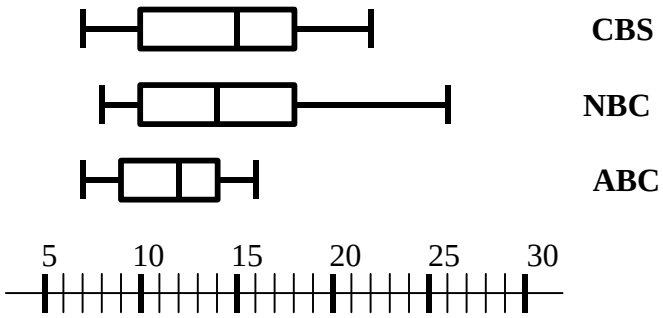
4. Given the following box-plot for a class of 28 test scores. Compare the number of students with scores in the 1st quartile to the number of students scores in the 4 th quartile.



   a. $Q^1 < Q^4$ **b. $Q^1 = Q^4$** c. $Q^1 > Q^4$ d. Can not determine

5. The box-plot below shows the television ratings for the three major networks.

Television Ratings



a. Which network has the largest interquartile range? **CBS**

b. Which network has the highest rating based on their median score? **CBS**

c. Which network has the highest rating based on the highest rated show? **NBC**

d. Which network has the highest rating based on the largest upper quartile? **NBC**

e. When comparing the relative positions of the networks why are box-plots better than stem-and-leaf plots?

Even though the stem-and-leaf plots let you see all the data, this can be confusing. Box plots let you focus on the 5 important numbers that you need to compare different sets of data.

Show all work in the space provided. Your work and answer will be scored.

6. The National Insurance Agency rated 40 models of cars based on the number of insurance claims filed for personal injury coverage. 100 represents the average for all cars. Lower numbers mean a better safety record. A rating of 115, for example, means 15% worse than average.

Safety Rating

Small Cars		**Large Cars**	
Mercury Lynx	83	Buick Electra	59
Toyota Tercel	91	Dodge Caravan	63
Ford Escort	95	Ford Crown Victoria	70
Subaru DL/GL98	98	Mercedes 300SD	60
Nissan Sentra	108	Jaguar X 16	63
Mercedes 380SL	57	Cadillac Eldorado	71
Chevrolet Corvette	71	Lincoln Town Car	72
Nissan 300ZX	100	Cadillac Seville	76
VW Rabbit	102	Mercury Grand Marquis	65
Mazda RX-7	104	Buick Electra	66
Pontiac Fiero	119	Chrys. 5th Ave.	69
Honda Accord	102	Ford Crown Victoria	65
Nissan Stanza	105	Buick LeSabre	70
Honda Prelude	114	Oldsmobile Delta	70
Toyota Celica	120	Mercury Grand Marquis	76
Dodge Daytona	122	Buick Electra	81
Ford Escort	130	Cadillac De Ville	81
Dodge Charger	132	Dodge Diplomat	72
Mazda GLC	130	Chevrolet Impala	79
Dodge Colt	144	Plymouth Grand Fury	101

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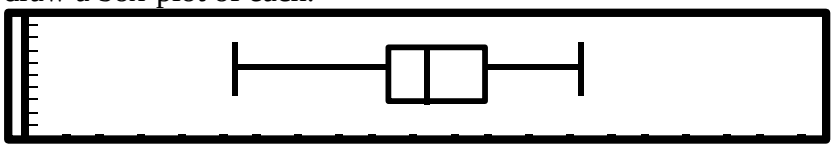
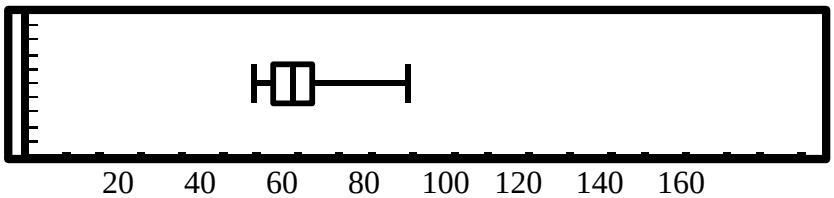


SMALL CARS



LARGE CARS

B. Using complete sentences, write 5 separate comparisons between the safety rating of small cars and large cars.

Both small and large cars had similar minimum safety rating (57 for small and 59 for larger)

The lower quartile of the data for small cars has a wider spread of 23 units as opposed to the spread of the lower quartile of the larger cars, which is 6 units.

The upper quartile of the data for small cars and larger cars was almost the same, 23 for small cars and 25 for large cars.

The median rating for the small cars, 104.5, is much higher than the median rating for the large cars, 70. You could say that the average small car has a rating about 30 points higher than the average large car.

The interquartile range shows that the variance for large cars is much smaller than the variance for the small cars, which shows that the large cars have a more consistent rating.

The Maximum rating for the small cars was one and a half times larger than the rating for the large cars.

The range also points out that the larger cars were more consistently rated, going from 59 to 101, while the small cars range from 57 to 144.